The Electron Beam Welding Process

Materials Suitability for EBW

The electron beam welding process delivers very high energy density at the weld joint and is operated in a high vacuum. This makes the process suitable for a wide range of materials. Many materials will exhibit as welded strength properties equal to or greater than the parent material. Joint designs can be optimized to increase as welded strength, and to minimize distortion and shrinkage. Materials suitable for electron beam welding include the following alloys:

- Aluminum Alloys
- Copper Alloys
- Steels
- Stainless Steels
- Nickel Alloys
- Cobalt Alloys
- Refractory Metals Including Tantalum, Tungsten, and Vanadium
- Titanium Alloys
- Precious Metals

Weld Joint Configurations

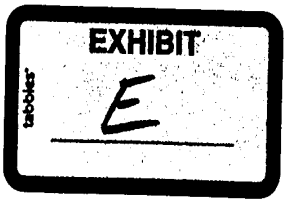
- Step Joints
- Butt Joints
- Plug and Counterbore
- Lap Joint
- Tube and Socket
- Other Non-Filler Weld Joints

Note: Unbacked full penetration weld joints should be avoided with EBW. If full wall thickness welds are required the joint design should include a weld backup strip or ring.

Electron Beam Welding Process

Electron beam welding is a high energy density welding process that produces welds which are smaller and have less distortion and are often stronger than those of arc welding processes. This process allows access to joints not readily weldable under the normal arc process. The welds produced will possess unique characteristics as a result of this process, such as high depth-to-width ratios (10:1) with extremely low heat inputs.

These low heat inputs also result in low thermal distortions, residual stresses and metallurgical changes



in the heat affected zone (HAZ). The spot size of the beam (0.01 to 0.03 in) also allows for very small parts or thin sheet materials to be precisely welded. This process also has application for performing closure welds on containers which must be evacuated since the process is performed in a high vacuum ($1x10^{-6}$ Torr).

Process

This fusion joining process utilizes a beam of high energy electrons directed onto the joint to be welded. The welding is performed under some level of vacuum with the highest penetration welds being delivered for the high vacuum systems. The range of focus and the energy density of the electron beam allow welding to be performed in either the conduction mode similar to GTA welding or the "keyhole" welding mode where deep penetration in a single pass is achievable. The energy density available allows high thermal conductivity metals and dissimilar metals to be easily welded. The low overall heat input also provides opportunities to join materials that are traditionally "unweldable" by normal arc processes. This process also provides for low contamination and oxidation during welding which is desirable for reactive metals or applications where oxidation needs to be avoided.

Advantages of electron beam welding

- EBW exhibits high depth-to-width ratio welds allowing for single-pass welding of thick joints.
- Cleaner, less visible welds are achieved in a vacuum; distortion and shrinkage are minimized and the heat affected zone is much smaller than in other welding processes.
- Can accommodate the most intricate parts and "inaccessible" locations.
- High energy density decreases welding time thereby increasing productivity.
- A wide range of working distances and welding shapes can be achieved through deflection of the beam to provide optimal weld quality.
- Dissimilar metals or metals with high thermal conductivity (copper) can be easily welded with this process.

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